

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : F16K 7/17, 15/14, 31/365, 31/385		A1	(11) International Publication Number: WO 97/42438
			(43) International Publication Date: 13 November 1997 (13.11.97)
(21) International Application Number: PCT/NZ97/00056		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 8 May 1997 (08.05.97)		Published With international search report.	
(30) Priority Data: 286543 8 May 1996 (08.05.96) NZ 299570 11 October 1996 (11.10.96) NZ			
(71) Applicant (for all designated States except US): HANSEN DEVELOPMENTS LIMITED (NZ/NZ); 156 Lower Dent Street, Whangarei 0101 (NZ).			
(72) Inventor; and (75) Inventor/Applicant (for US only): HANSEN, Albert, Frederick (NZ/NZ); 156 Lower Dent Street, Whangarei 0101 (NZ).			
(74) Agents: WEST-WALKER, Gregory, James et al.; Russell McVeagh West-Walker, The Todd Building, Level 5, 171-177 Lambton Quay, Wellington 6001 (NZ).			
(54) Title: A DIAPHRAGM VALVE			
(57) Abstract			
<p>A diaphragm valve for the water intake in irrigation systems or similar comprises a hollow body (1) having a port (1a) to connect a hydraulic or pneumatic system to the interior of the body of the valve and at least one ventilation opening through a side wall or walls of the body from the exterior to the interior of the valve. A diaphragm (7) is movably mounted within the interior of the body and normally closes the port. There is a bleed aperture through the diaphragm around the guide member (10) to a cavity (12) behind the diaphragm. When the pressure on the port side of the diaphragm falls below the external pressure, the diaphragm will move away from the port to open the port to fluid entering the interior of the body of the valve through the side wall(s) of the body of the valve, and the diaphragm will move to close the port when the pressure on the port side of the diaphragm is equalised with the external pressure. Preferably the diaphragm comprises a thin flexible annular skirt (7c) extending from the periphery of the diaphragm with the distal edge of the skirt retained in an annular recess (8) around the cavity behind the diaphragm to movably mount the diaphragm within the interior of the body of the valve so that the diaphragm moves by flexing and/or folding of the skirt.</p>			

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Cameroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

A DIAPHRAGM VALVE

FIELD OF INVENTION

- 5 The present invention comprises a diaphragm valve, particularly suitable for irrigation applications.

BACKGROUND OF INVENTION

- 10 Diaphragm valves of various types are used in various applications. Various designs and constructions for such diaphragm valves are known, which are generally relatively complicated multipart valves.

SUMMARY OF INVENTION

15

The present invention provides an improved or at least alternative form of diaphragm valve.

- In broad terms the invention comprises a diaphragm valve comprising a hollow body
20 having an outlet port to connect a hydraulic or pneumatic system to the interior of the body of the valve and at least one inlet port to the interior of the body of the valve, and a diaphragm movably mounted within the interior of the body and normally closing said outlet port with a cavity behind the diaphragm and a bleed aperture through the diaphragm from said outlet port into the cavity behind the diaphragm, such that when
25 the pressure on the outlet side of the diaphragm falls below the pressure on the inlet side of the diaphragm, the diaphragm will move away from the outlet port to open the

- 1 -

SUBSTITUTE SHEET (RULE 26)

port to fluid entering the interior of the body of the valve through the inlet port(s) and will move to close the outlet port when the pressure on the outlet side of the diaphragm is equalised with the pressure on the inlet port side of the diaphragm.

- 5 Preferably the diaphragm component includes a thin flexible annular skirt extending from the periphery of the diaphragm with the distal edge of the skirt retained in an annular recess around the cavity behind the diaphragm to movably mount the diaphragm within the interior of the body so that the diaphragm moves by flexing and/or folding of the skirt.

10

Preferably the skirt is integrally formed with a major part of the body of the diaphragm by injection moulding from a plastics material.

- The diaphragm valve of the invention is of a simple and robust construction and may
15 be formed entirely from plastic moulded components, although parts of the diaphragm valve of the invention may also be formed from metal by casting for example, particularly for larger sizes of valves of the invention.

- Diaphragm valves of the invention are particularly suitable for use in irrigation systems
20 or similar where water is drawn from a reservoir or stream. The valves of the invention will give reliable long term performance in such demanding applications. The valves of the invention are suitable for other applications also however, and are not limited to irrigation or like applications.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings show preferred forms of diaphragm valves of the invention, by way of example and without intending to be limiting. In the drawings:

5

Figure 1 shows a first preferred form valve assembled,

Figure 2 is a cross-sectional view through the preferred form valve of Figure 1 along line A-A of Figure 1 and showing the diaphragm of the valve closing the valve port,

10

Figure 3 is a cross-sectional view similar to Figure 2, through the preferred form valve of Figure 1, but showing the diaphragm moved away from its normal position to open the valve port to the exterior of the valve, and

15 Figure 4 is a cross-sectional view through a second preferred form of valve of the invention.

DETAILED DESCRIPTION OF PREFERRED FORM

20 The body of the first preferred form valve comprises a main body component 1 and an end cap 2 which when the valve is assembled closes the otherwise open end of the main body component 1. The end cap threads on to the threaded annular end 4 of the main body component 1.

25 The main body component 1 has a hollow interior and an outlet port by which the diaphragm valve may be connected to a pipe system. In the first preferred form valve

the outlet port is formed by an aperture 5 through the end of the main body component 1 opposite the end cap 2. The aperture 5 is internally threaded so that the valve may be threaded onto the end of a pipe such as that indicated in broken lines at 6 in Figure 3, forming part of the pipe system, so that the interior of the pipe communicates through the outlet port 5 and into the interior of the valve. Around the pipe connection aperture or port 5 the body of the valve may be hexagonally shaped with flats 1a to enable the valve to be tightened on to the threaded end of a pipe with a spanner for example. This is not essential as in smaller versions of the valve hand tightening alone may be sufficient.

10

A circular wall 5a depends from the pipe connection port into the interior of the valve as shown, to form a valve seat. The diaphragm 7 is mounted within the interior of the valve. In the preferred form the diaphragm is generally circular, and comprises a thin annular skirt 7a which extends from the periphery of the side walls 7b of the preferred form diaphragm as shown. The distal edge 7c of the skirt 7a is retained in an annular recess 8 in the end cap 2 as shown.

The skirt 7a is a thin, flexible skirt which can flex and fold to allow the diaphragm to move between the position shown in Figure 2 where the diaphragm seals against the circular wall 5 to close the outlet port, and the position shown in Figure 3 where the diaphragm 7 has moved towards the end cap 2 to open the port 5. As the diaphragm moves to its open position as shown in Figure 3, the thin flexible skirt 7a of the diaphragm flexes and folds to the shape shown in Figure 3. In the preferred form valve shown in the drawings the front face of the diaphragm 7 is shaped as indicated at 7e to engage the lower edges of the port walls 5a when the diaphragm closes the outlet port.

- 4 -

SUBSTITUTE SHEET (RULE 26)

The diaphragm is a separately moulded plastic component which is simply fitted to the cap 2 so that the edge 7c of the skirt of the diaphragm enters into the annular recess 8 in the cap and the diaphragm is not secured by screws or clamps or similar. This provides for easy assembly and a simple construction and moreover it has been found
5 that the diaphragm will effectively seal for both vacuum and pressure up to relatively high pressures.

The diaphragm valve of Figures 1 to 3 is suitable for use in irrigation systems or similar where water is drawn from a reservoir or stream for example by a pump. A
10 pipe from the intake of the pump is connected to the diaphragm valve which is immersed in the water supply to enable water to be drawn into the pump through the valve. In the valve of Figures 1 to 3 inlet apertures are formed through the side walls of the body of the valve to the interior, and in the preferred form shown these comprise a number of slots 18 arranged radially around the side walls of the main body
15 component 1 as shown.

The preferred form valve of Figure 4 is intended to be connected in series in a pipe system. In this form an inlet port 20 is provided on the other side of the main body component 1 of the valve. In Figure 4 the same reference numerals used in Figures
20 1 to 3 indicate the same components of the valve. The main body component is formed as shown to define a circular valve seat 5a, similar to that formed by the circular wall 5a of the valve of Figures 1 to 3. In Figure 4 arrow E indicates the direction of fluid flow through the valve (when the valve is opened).

25 In the preferred forms the diaphragm 7 including the integral skirt 7a are formed from a softer plastics material and the diaphragm has side walls 7b and an annular flange

7d, and a ring 16 of a harder material such as a harder plastics material is captured around the side walls 7b of the diaphragm as shown. An annular member 17 surrounding the diaphragm is fitted within the main body of the valve, and is retained in place when the cap 2 is screwed home. As the diaphragm moves during opening and closing in normal operation of the valve, the plastic ring 16 around the side walls of the diaphragm slides within the annular member 17, which helps to locate and guide movement of the diaphragm. In an alternative arrangement the annular member 17 may be integrally formed as part of the body of the diaphragm as an integral zone in the side wall of the diaphragm for example, if production techniques allow.

10

Preferably the annular member 17 has a top edge shape which slopes down towards the cap 2 from its inner circumference which improves the fluid flow and minimises flow direction change disruption through the valve when the diaphragm is in the open position.

15

Preferably the annular member 17 has a series of holes 17a extending from the shaped top edge of the member 17 through the member 17 towards the outer surface 7a of the diaphragm. The holes 17a are preferably equi-spaced around the member 17. These holes 17a allow the diaphragm valve to be self cleaning by allowing a flow of fluid to be carried over the flexible skirt 7a of the diaphragm and out through the gap between the annular member 17 and the support ring 16, as indicated by arrows D in Figure 3, at a velocity sufficient to ensure that any material being carried by the fluid is not able to settle out and cause the valve to malfunction. This feature is particularly useful when the valve is used with fluids that contain a significant burden of heavy materials.

25 In the first preferred form valve of Figures 1 to 3 these holes are vertical and aligned with the external slots 18 of the body 1.

A guide member 10 extends centrally from the cap 2 through an aperture 11 in the centre of the diaphragm 7 and towards the outlet port 5. The guide member 10 may be formed as a separate component from the cap 2 and threaded or otherwise connected to the cap as indicated at 14. The aperture through the centre of the diaphragm around the guide member 10 is slightly larger than the diameter of the member 10 and forms a bleed aperture through the diaphragm from the outlet port 5 to the cavity or space 12 behind the diaphragm, between the rear side of the diaphragm and the cap 2. The guide member 10 is not essential but is preferred to ensure reliable operation of the diaphragm. In the preferred form the guide member 10 has a cruciform shape in cross-section.

Preferably a spring 19 is positioned between the cap 2 and the diaphragm to aid skirt 7a in closing the diaphragm. The spring 19 is not essential but can be used to ensure reliable operation of the diaphragm.

15

In operation, if the pressure at the outlet port 5 falls ie there is a relative vacuum in the pipe system to which the valve is connected, produced by a pump for example, there will also be a reduction in pressure via the bleed aperture 11 through the diaphragm in the cavity 12 behind the diaphragm, and relative to the exterior of the valve in the valve of Figures 1 to 3 or relative to the inlet port 20 in the valve of Figure 4. This relative pressure imbalance will cause the diaphragm 7 to move towards the cap 2, from the position shown in Figure 2 to that shown in Figure 3, thus opening the outlet port 5 to the interior of the valve to allow fluid to pass through the slots 18 in the side walls of the coupling body 1 and through the outlet port 5, as indicated by arrows C in Figure 3. The shaped top of the annular member 17 causes the fluid to operate against the top surface of the diaphragm 7 thereby causing the diaphragm to

move towards the cap 2 further, and increasing the fluid flow through the valve. Subsequently the natural resilience of the thin flexible skirt 7a of the diaphragm together with the spring 19 will cause the diaphragm to pop or spring back to its original position shown in Figure 2 to close the port 5. The operation of the valve of

5 Figure 4 is identical, except that fluid enters the valve through inlet port 20.

As stated, preferably the diaphragm 7 is formed as a single injection moulded plastics component comprising the main body 7 of the diaphragm and the thin flexible skirt 7a.

- 10 Diaphragm valves of the invention may be formed in large and small sizes. Because the valve comprises relatively few components it is inherently robust and reliable in operation, and all of the components of the valve may be formed by injection moulding, or by metal casting for larger versions if desired.
- 15 The foregoing describes the invention including preferred forms thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated within the scope hereof as defined in the following claims.

CLAIMS

1. A diaphragm valve comprising a hollow body having an outlet port to connect a hydraulic or pneumatic system to the interior of the body of the valve and at least one inlet port to the interior of the body of the valve, and a diaphragm movably mounted within the interior of the body and normally closing said outlet port with a cavity behind the diaphragm and a bleed aperture through the diaphragm from said outlet port into the cavity behind the diaphragm, such that when the pressure on the outlet side of the diaphragm falls below the pressure on the inlet side of the diaphragm, the diaphragm will move away from the outlet port to open the port to fluid entering the interior of the body of the valve through the inlet port(s) and will move to close the outlet port when the pressure on the outlet side of the diaphragm is equalised with the pressure on the inlet port side of the diaphragm.
2. A diaphragm valve according to claim 1 wherein the diaphragm comprises a thin flexible annular skirt extending from the periphery of the diaphragm with the distal edge of the skirt retained in an annular recess around the cavity behind the diaphragm to movably mount the diaphragm within the interior of the body of the valve so that the diaphragm moves by flexing and/or folding of the skirt.
3. A diaphragm valve according to claim 2 wherein the skirt is integrally formed with a major part of the body of the diaphragm by injection moulding from a plastics material.
4. A diaphragm valve according to claim 3 wherein the hollow body comprises a main body component and a cap, and said annular recess is formed in the inside face

of the cap so that the cavity behind the diaphragm is defined between the inside face of the cap and the diaphragm.

5. A diaphragm valve according to claim 4, wherein a guide member extends centrally from the inside face of the end cap through the bleed aperture through the diaphragm.

6. A diaphragm valve according to any one of claims 1 to 5 wherein the inlet port(s) comprise(s) at least one ventilation opening through a side wall or walls of the body of the valve from the exterior to the interior of the valve.

7. A diaphragm valve comprising a hollow body having a port to connect a hydraulic or pneumatic system to the interior of the body of the valve and at least one ventilation opening through a side wall or walls of the body from the exterior to the interior of the valve, a diaphragm movably mounted within the interior of the body and normally closing said port, and a cavity behind the diaphragm and a bleed aperture through the diaphragm from said port into the cavity behind the diaphragm, such that when the pressure on the port side of the diaphragm falls below the external pressure, the diaphragm will move away from said port to open the port to fluid entering the interior of the body of the valve through the ventilation opening(s) through the side wall(s) of the body of the valve, and will move to close the outlet port when the pressure on the port side of the diaphragm is equalised with the external pressure.

8. A diaphragm valve substantially as shown in Figures 1 to 3 and described herein.

9. A diaphragm valve substantially as shown in Figure 4. and described herein.

1/4

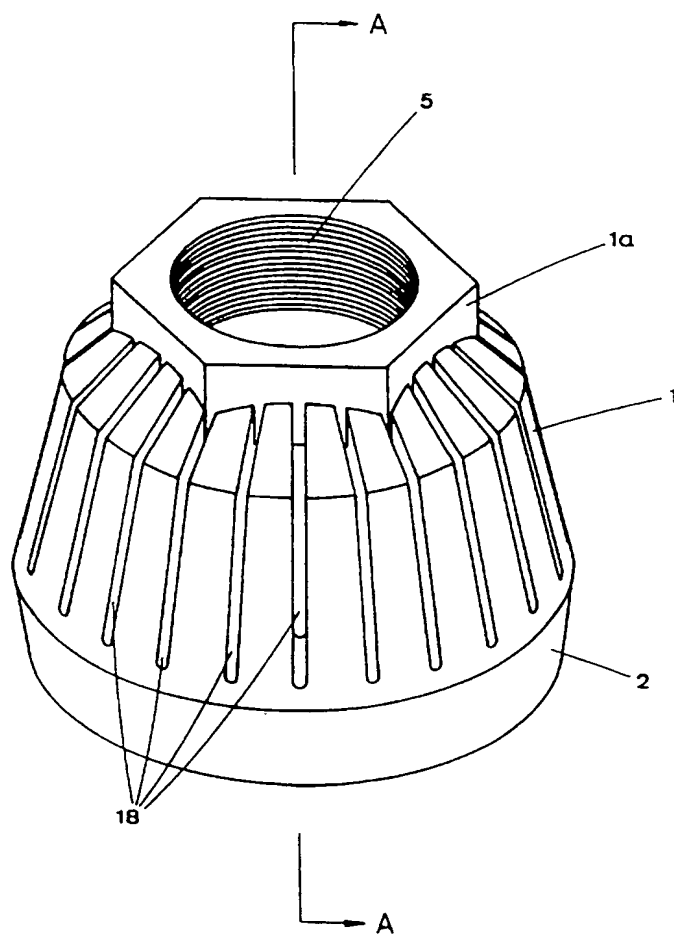


Figure 1

SUBSTITUTE SHEET (RULE 26)

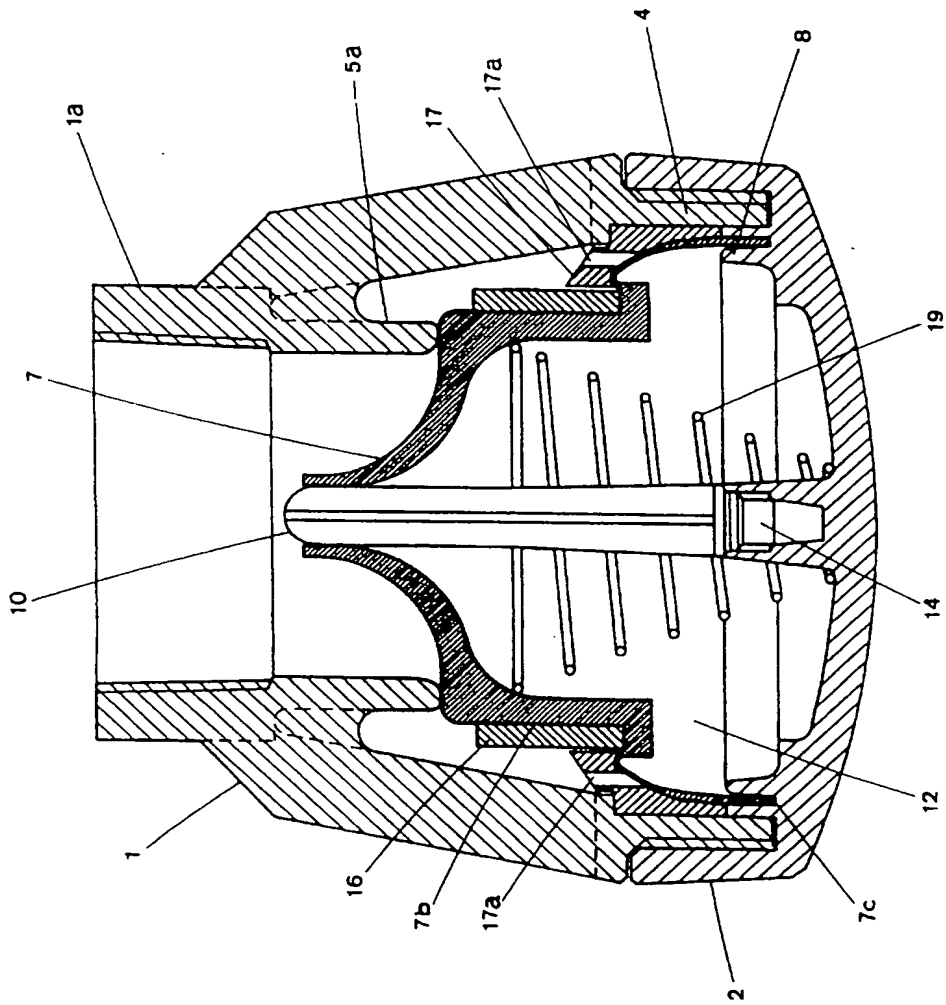


Figure 2

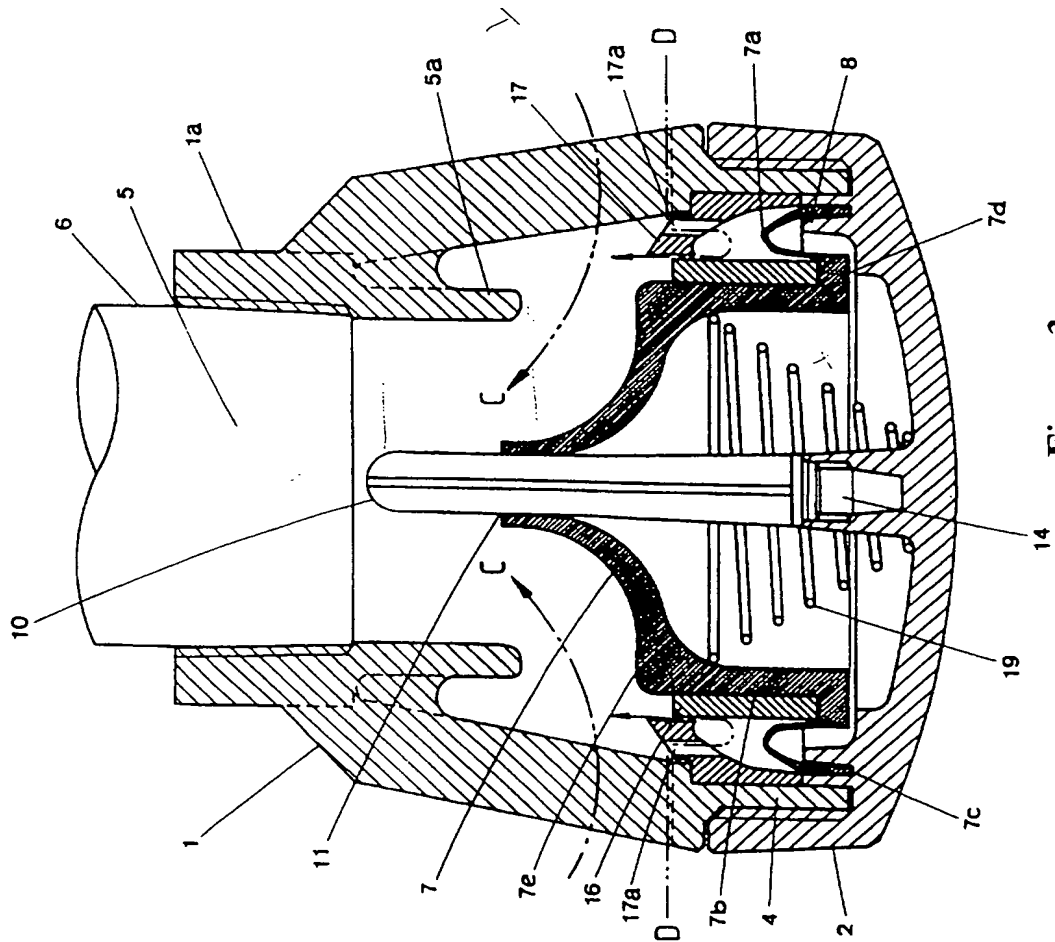


Figure 3

SUBSTITUTE SHEET (RULE 26)

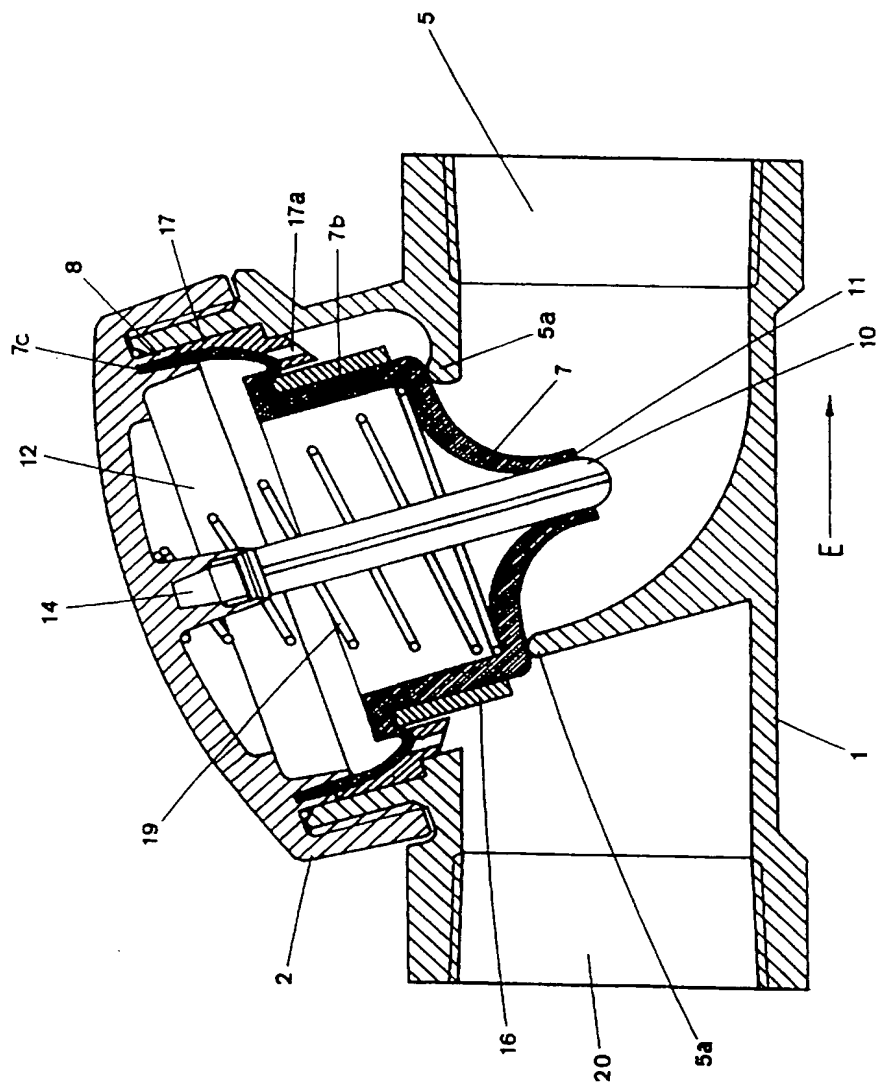


Figure 4

SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/NZ 97/00056

A. CLASSIFICATION OF SUBJECT MATTER		
Int Cl ⁶ : IPC F16K 7/17, 15/14, 31/365, 31/385		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC F16K 7/17, 15/14, 31/365, 31/385		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DERWENT		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AU 51290/73 (478426) B (HANSEN) 25 July 1974 entire document	1-9
X	AU 17520/76 (496181) B (AUTOMATIC SWITCH CO.) 16 March 1978 entire document	1-9
A	US 4 715 578 A (SELTZER) 29 December 1987 entire document	1-9
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 3 July 1997		Date of mailing of the international search report 11.07.97
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929		Authorized officer D. LOGAN Telephone No.: (06) 283 2386

Form PCT/ISA/210 (second sheet) (July 1992) copkus

Printed from Mimosa

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.

PCT/NZ 97/00056

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
AU	51290/73 (478426)	NIL					
AU	17520/76 (496181)	CA	1033260 A1	CH	610636 A	DE	2639801 A1
		FR	2324956 A1	GB	1514078 A	JP	52/039824 A2
		NL	7610444 A	US	4058287 A		
US	4715578	NIL					

END OF ANNEX